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PRELIMINARY REPORT ON DECAY IN SPROUT NORTHERN HARDWOODS IN RELATION TO TIMBER STAND IMPROVEMENT

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INTRODUCTION

Trees of sprout origin are generally considered inferior to trees of seedling origin for the production of sawtimber, owing to form defects and the tendency for decay to enter through the parent stumps. Since most of the valuable hardwood species sprout readily over large areas of the northern hardwood region, clear-cutting of immature stands has resulted in the establishment of stands composed mainly of sprouts. As the result of repeated coppicing, many hardwood stands are practically worthless for the production of other than low-grade forest products. Timber stand improvement on a large scale by the Civilian Conservation Corps has emphasized the need of greater knowledge of sprout hardwoods, especially with reference to conversion treatments designed ultimately to produce more valuable forest products.

Sprouts are peculiarly subject to decay in connection with the parent stump or from the old stump wound and from dead or cut companion sprouts. Roth and Sleeth /2/in a study of sprout oaks found that decay

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2/ Roth, Elmer and Bailey Sleeth. Decay in Sprout Oaks. Division of Forest Pathology, Bureau of Plant Industry mimeographed release. 1936.

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in such stands could be correlated with (1) diameter and height of parent stump; (2) height of sprout origin; (3) stump wounds; (4) time of heartwood formation; (5) and presence of dead or cut companion stubs. They also found that one fungus, Stereum gausapatum, was responsible for the decay in over 75 percent of the infected oak trees examined. They found that in a high percentage of cases, infection of the sprouts could be traced directly to decay in the parent stump.

This memorandum sets forth preliminary results of an extension of the oak study to northern hardwoods using the same methods. Information given here has been gained from dissection of 986 sprouts of various ages and species, from plots established during the 1936 and 1937 field seasons. 3/

3/ These plots were located at the Kane Experimental Forest, Allegheny National Forest, Kane, Pennsylvania; the Ellithorp Farm, Kane; the Susquehannock State Forest, Pennsylvania; the Erving, October Mountain, Monroe and Mohawk Forests, Massachusetts; and the Harvard Forest, Petersham, Massachusetts. The assistance of the cooperating agencies concerned is gratefully acknowledged.

With the exception of beech, which reproduces vegetatively mostly by root suckers, practically all of the northern hardwood species are vigorous sprouters. The species investigated to date are white ash, basswood, black cherry, paper birch, red maple, and sugar maple. Yellow birch, an important hardwood species in northern New England and in the Lake States, sprouts readily from small stumps, but to date insufficient work has been done on the species to include it in this report. Sprouts of these northern hardwood species develop for the most part from dormant buds, which are usually thickly clustered on the stem at or near ground line and which have direct connection with the first-formed wood of the original tree. Since sprouts arising from these dormant buds are subject to decay through the old stump connection and from the death or severance of companion sprouts, it is important to know methods of reducing decay hazards in such stands, particularly if they are to be utilized for the production of sawtimber, ties or other products requiring a high percentage of sound wood.

Preliminary work on sprout stands indicates that under certain conditions reasonably satisfactory sawtimber stands, of most hardwood species, can be developed from sprouts especially with decay-resistant species. The recommendations given here are strictly from the pathological angle, but have of necessity included silvicultural considerations. Since a discussion of certain silvicultural factors could not be avoided, it must be emphasized that they apply strictly to the problem in relation to pathological factors and for the Northeastern States, and should not be considered authoritative for wider application.

DECAY IN SPROUT STANDS OF NORTHERN HARDWOODS

This study has shown that considerable decay exists in certain northern hardwood stands of sprout origin. The percentages of infected trees per plot ranged from 7 to 70. Most of this decay entered the sprouts either directly from the old stump or, more generally, through the old stump wound. The term "old stump wound" refers to the opening left in the base of sprouts by the decay of the parent stump. The importance of the old stump or old stump wound as an avenue of entrance for decay is evident from the fact that on 7 plots from 50 to 100 percent of all decay present could be traced to the old stump. This was true of all species. Decay traceable to dead companion stubs was relatively unimportant in stands 30 years of age or younger, but became increasingly important as the stands matured. Decay from dead stubs was more important than decay from the parent stump only in the case of multiple-stem seedling sprouts or sprouts from small stumps. In such

cases decay entering through stubs became important after the trees were 40 years of age. In the case of sprouts arising from large stumps, decay from the stump was more frequent than decay from stubs, even in stands 40 years of age or older. For all plots studied the percentages of decay associated with stubs varied from 0 to 25 percent. Stem wounds not related to sprouting, root injuries, and other lesions of unknown origin were important entrance points for decay, and in certain areas were more important than decay from the old stump or stubs. However, since such hazards are not peculiar to sprouts, decay from such sources has not been considered in this discussion.

The northern hardwood species seemed to vary considerably in the amount of decay associated with the old stumps and stubs. The following species are tentatively arranged in order of their increasing liability to butt decay infections as indicated by results from the dissection plots: white ash, black cherry, sugar maple, basswood, paper birch, and red maple. In addition, sugar maple and red maple were subject to "blackheart", or discolorations from wounds. Paper birch was subject to "redheart", a discoloration common in connection with stubs and wounds. Both "blackheart" and "redheart" were often associated with decay, and the combination of the two was often particularly damaging to stems of sprout origin.

SPROUT DECAY IN RELATION TO THE PARENT STUMP AND TO SIZE OF PARENT STUMP AND HEIGHT OF ORIGIN

To date sprout-dissection work on northern hardwood species has indicated that direct decay infection from the parent stump, such as is common in oaks, is to be expected only in black cherry. In this species, slow decay of the parent stump, coupled with early heartwood formation in the sprout, and a tendency to high origins permitted a certain amount of direct decay infection. However, owing to the resistance of black cherry heartwood to decay, actual decay infection from the old stump was relatively low, especially in stands under 50 years of age.

In white ash, basswood, paper birch, sugar maple, and red maple, the parent stump, even when of large size, decayed rapidly, and primary decay fungi became inactive before sufficiently mature wood susceptible to successful infection had formed in the sprout. Butt rot in sprouts of these species entered through the old stump wounds and was but rarely transmitted directly from the old stump. The stump wound exposes the oldest or most mature wood of the sprout at the point of sprout origin, and fungi entering here have direct access to that portion of the stem most susceptible to decay. With sugar maple, red maple, and paper birch, various staining organisms also entered through this old stump wound and caused defect separately or in conjunction with decay.

Sprouts arising from large stumps had larger stump wounds than sprouts from small stumps. Also sprouts originating high on the parent stump had larger stump wounds than those originating low on the stump.

As a consequence sprouts from small stumps 2-4 inches in diameter with low origins healed rapidly and were found to be safe from decay. Sprouts with high points of origins and from stumps larger than 4 inches in diameter healed slowly, and sprout stems surviving to 76 years were noted with large unhealed wounds. Open stump wounds were less serious in white ash than in sugar maple or paper birch, as the former species seemed resistant to decay infection and was not subject to discolorations. Stump wounds that healed before the sprout reached 35 years of age seemed to offer but slight decay hazards in ash and black cherry. Stump wounds that healed within 30 years seemed safe in sugar maple, while for basswood and paper birch such wounds needed to heal within 25 years for equal safety. Red maple sprouts, regardless of stump size, were often defective and ordinarily would not be considered as potential sawtimber crop trees.

Timber stand improvement operations in sprout hardwoods must aim at a reduction of the number of stems in sprout clumps and the favoring of seedlings, seedling-sprouts, or those sprouts of desirable origin from small stumps which are free from form defects. The reduction of the number of stems in a clump is necessary not only to secure less crown competition but also to prevent undesirable stub conditions at a later date. Treatment early in the life of the stand is desirable. For best results clump reduction work should be carried out before the stands are 20 years of age. The decay hazard in all species is low when the trees are young and exposed surfaces on cut stubs will therefore be chiefly sapwood and not subject to extensive decay.

In selecting sawtimber crop trees sprouts from small stumps should be favored whenever possible. No hard and fast rule can be stated as to the maximum size of the old stump, as this may vary with species. For the decay-resistant species such as ash and black cherry sprouts from stumps up to 8-10 inches may be reasonably safe, provided growth is sufficiently rapid to heal the stump wounds before approximately 35 years of age. For less resistant species, sprouts from smaller stumps should be selected, since stump wounds should be completely healed at an earlier age. Sprouts from stumps under 4 inches will be reasonably safe for all species provided clump reduction takes place before 20 years. Sprouts from stumps 4-10 inches may be safe, depending on age of treatment and the rate of growth of the remaining sprout. The essential thing is not the stump size but the age at which the old stump wound is completely healed. In case the stump wound is so large as to remain open during the life of the tree, such a tree will naturally be a poor risk and should not be selected as a crop tree. White ash appears to be somewhat of an exception, as old ash, 75 years or more old, with large stump wounds which indicated large parent stumps were sound in a number of instances. Even when decay was present in ash of this type it was limited to the first 5 or 6 feet of butt.

SPROUT DECAY IN RELATION TO STUBS

Decay entering through stubs of companion sprouts was found in all species studied. This was especially true of trees 40 years of age or older. Decay from stubs varied with the species, with the size and the

length of time the stubs were dead, and with the position of the stubs in relation to the surviving sprouts. Large stubs with direct heartwood or mature wood connections with the sprout were particularly dangerous. Small stubs under 2 inches were relatively safe.

The number of stems that survived to 20 years of age in a sprout clump depended somewhat upon the size of the parent stump. Sprout clumps developing from small stumps produced 2 or 3 surviving sprouts, while clumps from larger stumps often had many more stems. Sprout clumps, especially those from small stumps either developed as (1) equal sprouts, which grew at the same rate with equal chances of ultimate survival, or (2) unequal sprouts where one sprout assumed dominance while the others became more or less suppressed. In the growth process equal sprouts had a tendency to fuse and form high unions, so that separation without an attendant high decay hazard was possible only when the sprouts were young. The unequal sprouts from small stumps were less apt to fuse at the bases, and here the suppressed sprouts could be cut without endangering the dominant sprout. Various degrees of unequalness of stems in sprout clumps occurred, natural death of the more suppressed sprouts taking place early with practically no decay hazard.

Sprouts from small stumps were found to have points of origin close together. As multiple sprouts from such small stumps originating close to a common center grew and enlarged, their bases fused and subsequent removal by death or severance of one sprout opened a direct path for decay fungi to reach the heart of the remaining sprout. This was especially true if heartwood-rotting fungi became established in the stub. Early death or severance of small sprouts seemed to offer no decay hazard, as most sapwood-decaying fungi which attacked such stubs were unable to affect the living sprout. In clumps from larger stumps the individual sprouts were usually farther apart and fewer were joined by heartwood; therefore decay infection of one was not transmitted readily to the heart of the remaining sprout or sprouts.

In reducing the number of sprouts in a clump, the sprout with the most vigor, indicating favorable placement in respect to the root system, should be left as the crop tree, providing it has desirable form. Under no conditions should weak, suppressed sprouts be favored, as such sprouts are usually defective as to root placement and may be overtaken again later by sprouts from the vigorous stubs. In removing a companion sprout, the general principle is to cut flush or as near flush as practicable if the companion sprout is close enough or large enough so that complete and rapid healing must take place in order to protect the favored sprout from decay. If no healing is required, as in the case of widely separated sprouts in the same clump, a high cut may be used, provided the stub that is left is not over 2 or 3 inches in diameter. High-cut stubs, especially in young stands, usually decay at the base before the stub itself decays, and in falling over leave only a small hole in the sapwood ring at the base, which heals readily. In dealing with equal sprouts from small stumps or with closely spaced sprouts, high cuts may cause

the stub to persist so long that the remaining sprout grows against the dead stub and causes friction on the bark and damage to the bark. Such close persistent stubs are particularly damaging in maple, as the thin bark of the maple falls away at the point of contact leaving bare wood in contact with the decaying stub. While decay may not enter from such injuries in young sprouts, bark canker infections or discolorations which lower the quality of the wood, will be quite common. Therefore low-cut stubs are to be preferred in the reduction of closely spaced sprouts.

SPROUT DECAY IN RELATION TO ROOT SYSTEM

All species studied made use of the old root system, meaning by this the large main roots. Decay of the parent stump usually extended into the large main roots, and many sprouts, especially those from large stumps, had hollow main roots. Active Armillaria decay was very common in the vicinity of the old stump wounds which extended into the roots, but was not important in most species. In paper birch, however, Armillaria seemed to pave the way for extensive "redheart" infections. One fungus, Poria cocos, has been found to enter through the roots and to cause extensive butt decay. In general, root wounds such as result from the decay of the stump and portions of the old root system, appeared to be negligible entrance points for butt rots.

SPROUT DECAY IN RELATION TO HEARTWOOD FORMATION

In oaks the time of heartwood formation has an important bearing on decay transmission from the parent stump to the sprout. The northern hardwoods varied considerably in heartwood formation and no definite relation between time of formation and sprout decay was noticed. Only two, ash and black cherry, formed heartwood early in the life of the sprout as is common in oaks. Even in these species, it was noticed that sprouts of low origins, which had the points of union insulated from the stump wound by living sapwood, were rarely decayed. Red maple formed an indefinite heartwood early in life. This heartwood was often obscured, especially at the base of the sprouts, by extensive "blackheart" discolorations. Sugar maple did not appear to form a definite heartwood at least within 35 to 40 years and was resistant to butt decay probably for this reason. Paper birch lacked true heartwood even in old stems. "Redheart" has been referred to as heartwood in the past but is probably of pathological origin.

FUNGI RESPONSIBLE FOR DECAY IN SPROUTS

No one fungus appeared to cause most of the decay in a given species. The fact that direct decay transmission from the parent stump was rare in the species studied probably accounts for this. Armillaria mellea was recovered often from ground level samples of all species, but rarely extended high enough to be considered as a butt rot. "Redheart" in paper birch consistently gave Torula spp. and bacteria. The same was true of "blackheart" in sugar and red maples.

TENTATIVE RECOMMENDATIONS

1. Favor seedlings or seedling-sprouts for crop trees whenever possible. The following recommendations apply to the treatment of sprouts where seedlings and seedling-sprouts of the desired species and form are not available:

2. Early treatment, if possible before the stand is 20 years of age, is desirable. Such early treatment permits better selection of crop trees from the standpoint of stump and stub-wound decay hazards, and introduces the least possible danger from wounds incident to reduction of the number of stems in a clump.

3. Sprouts of decay-resistant species should be favored, but only when of desirable form and on sites favorable to the development of such species. The following species are listed tentatively in decreasing order of resistance to butt infections: white ash, black cherry, sugar maple, basswood, paper birch 4/ and red maple.

4/ Paper birch, while quite resistant to upward spread of decay infections, is subject to "redheart", especially in connection with stump wounds and stubs. This "redheart" becomes particularly severe in sprouts which suffer ice damage to tops when 35 years old or older. Paper birch is also short-lived and trees of any origin over 60 years old are apt to have much "redheart". The comparative value of paper birch and other species in a given locality should determine to what extent it should be favored or discriminated against.

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4. For sawtimber production, red maple sprouts should be discriminated against at all times. Other considerations such as soil improvement, gypsy-moth resistance, and use for fuelwood and other short rotation products, should be taken into account. However, red maple sprouts, even under favorable conditions, have little promise as sawtimber.

5. Select crop trees from sprout clumps arising from stumps 4 inches or less in diameter, whenever possible. Sprouts from larger stumps may, if necessary, be selected if of low origin and with small stump wounds. To reduce the decay hazard in the sprouts, stump wounds should be healed within 35 years for ash and black cherry, 30 years for sugar maple, and 25 years for basswood and paper birch.

6. In reducing sprout clumps, select the most vigorous sprout for the crop tree, provided form and pathological factors are equal. Single-stemmed individuals are preferable to those joined at the bases with other sprouts.

7. Avoid unnecessary wounding of the favored sprout. All cuts involving the favored sprout in any manner should be flush or as near flush as practicable, so as to heal rapidly. This applies to companion sprouts which touch the favored sprout or make any kind of union with it.

8. With closely spaced sprouts, even when small, and with sprouts over 20 years of age, all cuts in removing companion sprouts should be low ones, leaving stubs under 1 foot in height.

9. High cuts, leaving stubs of more than 1 foot, are permissible with sprouts 2-3 inches in diameter, provided such stubs are sufficiently wide-spaced so that friction between the favored sprout and the severed stubs will not occur before the stubs are completely decayed.

10. Suppressed companion sprouts in a clump should not be left as trainers for the favored sprout, unless they are sufficiently separated from the favored sprout to be eliminated before growth of the latter makes contact with them.

11. In stands over 20 years of age, large sprouts not having a common point of origin and not connected at the base may be removed with a slight decay hazard in ash and black cherry, and with a moderate decay hazard in sugar maple, basswood, and paper birch. A low cut should be used.

12. In stands over 20 years of age sprout pairs or clumps with high unions should be either left untouched or removed entirely.

13. These recommendations apply to sprout stands on good sites. On poorer sites where growth is slow and stump wounds and other wounds consequently heal slowly, sprouts from smaller stumps than could be safely used on good sites must be selected. This principle applies to all species.

14. No hard and fast rules can be made to apply to all cases since the selection of individual sprouts as crop trees and their treatment will differ with each species and stand. Sprout treatment should aim at (1) promoting rapid healing of the stump wound by speeding up growth rate of the favored stems; (2) prevention of stub decay hazards later in the life of the sprouts; and (3) where sawtimber is the aim, the selection and favoring of those individual sprouts best suited for high quality timber.

15. This study was concerned with northern hardwoods, and recommendations are made for northern hardwood sprout stands. In transition zones, where oak is common, the previously mentioned Roth-Sleeth mimeograph should be consulted.

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